Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters	)	IB Docket No. 16-408

REPLY COMMENTS OF VIASAT, INC.

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ViaSat, Inc. replies to the comments filed in response to the *Notice of Proposed Rulemaking* adopted on December 14, 2016 ("*NPRM*"). In the *NPRM*, the Commission proposes "revisions to certain of [its] rules and policies governing satellite services, prompted by a planned new generation of large, non-geostationary satellite orbit (NGSO), fixed-satellite service (FSS) systems" and to "update certain rules governing operation of FSS space stations in the geostationary-satellite orbit (GSO) to enable greater operational flexibility."[1]

I. INTRODUCTION AND SUMMARY

The *NPRM* represents the first attempt to comprehensively reform the Commission's NGSO licensing rules in nearly two decades. At that earlier time, the Commission licensed NGSO systems and adopted GSO/NGSO sharing rules for parts of the Ku band based on then-prevalent NGSO and GSO technologies and system designs. In doing so, the Commission built on technical analysis completed by the International Telecommunication Union ("ITU"), which (among other things) assumed that GSO networks would support only the low-throughput communication types prevalent at the time, and that the nature and extent of NGSO systems would be self-limiting due to the need to control self-interference, as well as other technical factors.

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1 *NPRM* ¶ 1.

In the intervening period, NGSO and GSO technologies have evolved significantly, rendering invalid the assumptions underlying the Commission's (and the ITU's) previous analyses. When ViaSat-1 was launched in 2011 (over a decade after the ITU first addressed Ka-band NGSO/GSO sharing criteria), it was the first true broadband satellite, providing a total throughput of approximately 150 Gbit/s; today it is used to offer speeds of 25 Mbit/s and higher. ViaSat's second- and third-generation broadband satellite designs provide even more impressive capabilities. ViaSat-2, planned for launch in the next month, will support peak speeds of 100-plus Mbit/s. ViaSat-3, planned for launch in 2019, will provide over one terabit per second (1,000 Gbit/s) of throughput and burst speeds in the 1 Gbit/s range.[2] These exponential increases in spectral efficiency and throughput rely on fundamental changes in GSO network designs that are essential to enable continued reductions in the "cost per bit" of broadband service, to support the growing numbers of satellite broadband subscribers, and to satisfy the insatiable demand for video streaming that consumes ever-increasing amounts of satellite capacity.

At the same time as these developments in GSO technology are occurring, the Commission is poised to authorize new NGSO systems for the first time in decades. The proposed networks are both more numerous and more technically diverse than those previously proposed to, and authorized by, the Commission in the Ku band or the Ka band. More specifically, the Commission is now faced with the possibility of authorizing *eleven* NGSO systems in the current Ka-band processing round alone, and *nine* NGSO systems in the V-band

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[2] *See, e.g., ViaSat Announces Third Quarter Fiscal Year 2016 Results* (Feb. 9, 2016), *available at* http://investors.viasat.com/releasedetail.cfm?ReleaseID=954130.

processing round.[3] These many systems vary significantly in their size, shape, and technical characteristics, and are briefly summarized in the following table.

Table 1: Number of Satellites per System and per Band[4]

	Ku band	Ka band	V band
Audacy		3	
Boeing		60	2,956
Boeing 2			147
Karousel	12		
Kepler	140		
LeoSat		84	
O3b		60	24
OneWeb	720		2,000
SpaceX	4,425		11,943
Space Norway	2		
Telesat Canada		117	117
Theia	120		
ViaSat		24	
# Systems	**6**	**11**	**9**
# Satellites	**5,419**	**5,627**	**17,334**

This proceeding will establish, in whole or in part, the service rules that will govern how these new NGSO systems will be licensed, how they will operate, and the extent to which they are able to coexist with each other and with GSO networks. Notably, these NGSO systems will have expected lifetimes of fifteen years or more. As such, there may be no realistic opportunity to adjust that framework again in the near future. For this reason, it is critical that the

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[3] The V-band processing round closed on March 1, 2017; most of these V-band proposals were filed after the February 27, 2017 comment date in this proceeding and thus were not discussed in ViaSat's initial comments.

[4] These data are based on the constellation parameters contained in the Schedule S forms submitted by each of the applicants in the current Ku/Ka-band and V-band processing rounds, with the exception of the SpaceX V-band system, where SpaceX submitted additional orbital parameters in a database file. With that one exception, the number of satellites listed for each system is the value reported in Schedule S as the "Total Number of Satellites in the active constellation" for each proposed system.

Commission fully explore all relevant issues *now* so it can develop and adopt rules that properly reflect the needs and capabilities of today's and tomorrow's GSO networks, and ensure compatible operations between and among various GSO and NGSO systems.

Unfortunately, the current state of the record in this proceeding does not allow the Commission to achieve these objectives. And the record certainly does not provide any basis for adopting the means of NGSO-NGSO coexistence in the same spectrum, or the NGSO-GSO protection criteria, proposed in the *NPRM*.

Commenting parties simply assume—without providing any technical analysis whatsoever—that it is appropriate to apply technical standards developed nearly twenty years ago, in another context, to today's GSO satellite networks that have fundamentally different technical characteristics. Among other things, parties assume that the equivalent power flux-density ("EPFD") limits found in Article 22 of the ITU Radio Regulations—first adopted in 2000—are sufficient to protect today's GSO networks from harmful interference.[5] But as ViaSat established in its initial comments, those limits are *not* sufficient, and nothing in the record demonstrates otherwise. Nor have any suitable EPFD limits even been proposed for the V band in this proceeding.[6]

In addition, the record provides no basis for adopting *NPRM* proposals intended to facilitate use of the same frequencies by multiple NGSO systems. Commenting parties fail to consider how certain of those proposals—and, in particular, the proposal to rely on the "avoidance of in-line interference" mechanism in making NGSO system spectrum

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[5] These ITU-R limits form the basis for the EPFD limits the *NPRM* proposes to apply to portions of the Ka band. The *NPRM* does not propose any EPFD limits for the V band.

[6] EPFD limits are being considered as part of the WRC-19 preparation process under Agenda Item 1.6.

assignments—would actually harm the provision of competitive services by other NGSO systems. For example, ViaSat demonstrated in its initial comments that the proposed spectrum assignment mechanism would force smaller networks like VIASAT-NGSO to sacrifice significant levels of coverage and capacity to avoid in-line events with much-larger NGSO systems, all to the detriment of the consumer, while having virtually no impact on the coverage or capacity of the much larger NGSO systems.[7]

While the record provides no data to support these proposals, it does make one point abundantly clear: Certain applicants in the pending Ka- and V-band processing rounds, which have applied for system designs that do not comply with longstanding FCC application requirements and baseline processing round qualifications, now seek to overcome their fundamental deficiencies, and avoid the risk of dismissal, through improper and inequitable post-cutoff notice rule changes. Doing so not only is unsustainable legally, but also would reward those applicants for proposing non-compliant systems, while effectively handicapping those applicants that responsibly designed and proposed FCC-compliant networks in the first instance. And doing so would place the risk and burden associated with the proposed NGSO co-existence rules on applicants that filed compliant applications well before this proceeding ever started.

The Commission should not countenance these efforts. Instead, the Commission should ensure that NGSO systems are licensed in a manner that preserves the integrity of the Commission's rules while facilitating the ability of NGSO systems to fairly operate along with each other, and also reasonably share spectrum with GSO networks.

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[7] Comments of ViaSat, Inc., IB Docket No. 16-408, at 20, Ex. 1 & 2 (filed Feb. 27, 2017) ("ViaSat Comments").

To achieve these objectives, ViaSat urges the Commission to: (i) adopt both single-entry and aggregate EPFD limits specifically designed to protect today's high-throughput GSO network designs from harmful interference resulting from the significant number of NGSO systems proposed in the pending Ka-band and V-band processing rounds; (ii) develop a mechanism to ensure that suitable aggregate EPFD limits in the space-to-Earth, space-to-space, and Earth-to-space directions are honored and that critical GSO operations are therefore protected; (iii) authorize NGSO operations in specific band segments based on "band-splitting," instead of requiring applicants to rely on the "avoidance of in-line interference" mechanism, and allow NGSO systems to coordinate with each other to define mutually acceptable terms on which they may access additional spectrum; and (iv) dismiss all pending Ka- and V-band NGSO applications (without prejudice to refiling) and initiate new processing rounds *after* this proceeding has been fully resolved, and new service rules are established and become effective, to avoid otherwise providing impermissible advantages to those applicants that have proposed systems that do not satisfy longstanding FCC application requirements and baseline processing round qualifications.

II. PROPOSED EPFD LIMITS WOULD *NOT* ADEQUATELY PROTECT EXISTING OR FUTURE GSO NETWORKS

The record reflects widespread recognition of the need to ensure that NGSO system operations do not adversely impact GSO operations. For example, SES and O3b recognize the need to utilize appropriate technical limits to ensure that NGSO FSS systems operating in the Ka band do not cause unacceptable interference to GSO FSS operations.[8] Inmarsat urges the Commission to ensure that NGSO operations in the Ka band "operate in such a way that any

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[8] Comments of SES S.A. and O3b Limited, IB Docket No. 16-408, at 19 (filed Feb. 27, 2017) ("SES/O3b Comments").

unacceptable interference shall be rapidly eliminated."[9] OneWeb recognizes the need for appropriate technical limits to ensure that GSO operations are adequately protected.[10] Boeing similarly recognizes the need for NGSO systems to inhibit transmissions within a "GSO protection zone" around the equator in order to "protect GSO systems."[11]

Although ViaSat welcomes such acknowledgments of the need to protect essential GSO operations, no commenter provides a workable solution for ensuring that GSO networks are actually protected. In particular, no commenter establishes that the EPFD limits proposed by the Commission would be sufficient to protect today's GSO networks from harmful interference generated by the *eleven* NGSO systems proposed in the pending Ka-band processing round. Instead, various commenters simply assume this to be true.[12] But there is no basis for this assumption, particularly because the satellite technologies and network architectures that were prevalent nearly two decades ago, when the EPFD limits were first developed at the ITU, are no

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9 Comments of Inmarsat, IB Docket No. 16-408, at 9 (filed Feb. 27, 2017) ("Inmarsat Comments").

10 Comments of OneWeb, IB Docket No. 16-408, at 22-23 (filed Feb. 27, 2017) ("OneWeb Comments").

11 Comments of The Boeing Company, IB Docket No. 16-408, at 4 (filed Feb. 27, 2017) ("Boeing Comments"). Notwithstanding its recognition of the need to protect GSO operations, Boeing raises vague concerns about the extension of certain NGSO "compliance measures" to the Ka band. *See id.* at 9. Boeing makes no effort to explain *which* compliance measures it views as unnecessary in the Ka-band context, frustrating any effort to meaningfully address its "concerns." In any event, for the reasons set forth elsewhere in these reply comments, it is critical to ensure that GSO operations in the Ka band and elsewhere are fully protected, and ViaSat urges the Commission to act accordingly.

12 *See, e.g.*, Comments of Kepler Communications Inc., IB Docket No. 16-408, at 2 (filed Feb. 27, 2017) ("Kepler Comments"); Comments of LeoSat MA, Inc., IB Docket No. 16-408, at 10 (filed Feb. 27, 2017) ("LeoSat Comments"); Boeing Comments at 4; OneWeb Comments at 22-23; Comments of Space Norway AS, IB Docket No. 16-408, at 8 (filed Feb. 27, 2017) ("Space Norway Comments"); Comments of Space Exploration Technologies Corp., IB Docket No. 16-408, at 5 (filed Feb. 27, 2017) ("SpaceX Comments").

longer the norm today. Moreover, as ViaSat explained in its comments, the Commission's experience with the licensing and operations of the current O3b constellation simply does not translate into a means for managing the many different types of NGSO constellations now before the Commission.[13] And neither the *NPRM* nor any commenter addresses what EPFD limits would be suitable to ensure GSO and NGSO compatibility in the V band.

EFPD limits are proposed to be the sole mechanism for ensuring that GSO networks actually are protected from harmful interference resulting from NGSO operations in the Ka band.[14] Moreover, the Commission has previously licensed GSO networks and hybrid GSO/NGSO networks in the V band,[15] but the Commission has never before licensed a single stand-alone NGSO network in the V band, let alone *nine stand-alone NGSO networks with well over 17,000 NGSO spacecraft.* In these circumstances, it is essential that the Commission develop and adopt EPFD limits for *both* the Ka band *and* the V band that adequately protect current GSO network technology from NGSO interference.[16] It is essential that such development and adoption occur before any NGSO systems in the pending Ka-band and V-band processing rounds are authorized.

If the Commission instead intends to rely on the general terms of No. 22.2 of the ITU Radio Regulations, that decision should be made expressly clear. In that case, it would be

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13 ViaSat Comments at 16-17.

14 *NPRM* ¶ 19 n.52 ("We intend that compliance with EPFD limits in the Ka-band would satisfy any obligation on an NGSO FSS system to operate on a non-interference basis with respect to a GSO FSS networks.").

15 *See, e.g.*, Stamp Grant, Hughes Network Systems, LLC, IBFS File No. SAT-LOA-20111223-00248 (Aug. 3, 2012); *Northrop Grumman Space & Mission Systems Corp.*, 24 FCC Rcd 2330 (2009) ("*Northrop Grumman Order*").

16 Such limits also should apply to the 18.8-19.3 GHz and 26.6-29.1 GHz band segments, in which the Commission proposes to elevate GSO use to co-primary status. *See NPRM* ¶ 12.

essential that the consideration of both (i) the eleven NGSO applications and the over 5,600 satellites proposed in the pending Ka-band processing round, and (ii) the nine NGSO applications and the over 17,000 satellites proposed in the pending V-band processing round, include a full assessment of their aggregate impact on the operation of GSO spacecraft.

A. Commenting Parties Do Not Establish that Proposed Uplink EPFD Limits Would Adequately Protect GSO Networks

The uplink EPFD limits proposed in the *NPRM* would not adequately protect GSO networks from interference generated by the NGSO systems proposed in the pending processing rounds. This interference is likely to be significant, as illustrated by the following tables.

Table 2 presents a link-budget analysis demonstrating how emissions from a single NGSO system would impact ViaSat's first-, second-, and third-generation broadband satellite designs. This analysis assumes that the uplink EPFD emissions from all co-frequency NGSO earth stations of that single NGSO system are at the limit set forth in proposed Section 25.208(k)—*i.e.*, -162 dBW/(m^2 * 40 kHz). As depicted in Table 2, ViaSat's first-generation broadband satellite (*i.e.,* ViaSat-1) would experience 0.6 dB of uplink noise floor degradation from the NGSO earth stations of a single NGSO system operating at this limit. ViaSat's second- and third-generation broadband satellites would experience 3.2 dB and 4.5 dB of uplink noise floor degradation, respectively. In real-world terms, this equates to a significant loss of the GSO satellite's uplink capacity in any given beam. In short, NGSO system operations that create uplink EPFD at the limit proposed in the *NPRM* are predicted to have a significant adverse impact on the operations of today's GSO networks—including, but certainly not limited to, those currently operated and planned by ViaSat.

Table 2: Impact of Uplink EPFD from a Single NGSO FSS System

	ViaSat 1st Gen	ViaSat 2nd Gen	ViaSat 3rd Gen
Frequency (MHz)	29750	29750	29750
Lambda (m)	0.010	0.010	0.010
EPFD (dBW/(m^2 * 40 kHz))	-162.0	-162.0	-162.0
Conversion factor 40 kHz to Hz (dB)	46.0	46.0	46.0
EPFD (dBW/(m^2 * Hz))	-208.0	-208.0	-208.0
Meter squared antenna gain (dB(m^2))	50.9	50.9	50.9
Satellite receive antenna gain (dBi)	53.0	61.0	61.0
Interfering power received from NGSO (dBW/Hz)	-205.94	-197.94	-197.94
Satellite Noise Temperature (K)	1350.0	1050.0	650.0
Satellite G/T (dB/K)	21.7	30.8	32.9
Thermal Noise Density, N_o (dBW/Hz)	-197.3	-198.388	-200.471
Interference Noise Density, I_o (dBW/Hz)	-205.94	-197.94	-197.94
I_o/N_o (dB)	-8.6	0.4	2.5
Uplink Degradation (dB)	0.6	3.2	4.5
$\Delta T/T$ (%)	13.7	110.9	179.1

Notably, Table 2 shows the impact of only a *single* NGSO system and does not account for the aggregate impact of the *eleven* NGSO systems proposed in the ongoing Ka-band processing round, each of which would contribute to the aggregate EPFD received by any given GSO satellite from co-channel NGSO earth station operations.[17] Table 3, below, depicts the aggregate impact of multiple NGSO systems, each operating at the -162 dBW/(m^2 * 40 kHz) uplink EPFD limit proposed in the *NPRM*. With 5,627 satellites planned by the eleven entrants in the current Ka-band NGSO processing round, it is certainly possible that more than one NGSO system could cause interference to a given GSO satellite. Among other things, unwanted energy from multiple systems could combine as the result of off-axis emissions, including through side lobes.

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[17] The proposed single-entry limit is based on Article 22 of the Radio Regulations, which only addresses single-entry limits, and which refers to Resolution 76 for limits on aggregate interference. However, Resolution 76 does not address aggregate uplink interference; it addresses only aggregate downlink interference.

Table 3: Impact of Aggregate Uplink EPFD from Multiple NGSO FSS Systems[18]

	Uplink Degradation (dB)		
# Systems	ViaSat 1st Gen	ViaSat 2nd Gen	ViaSat 3rd Gen
1	0.6	3.2	4.5
2	1.0	5.1	6.6
3	1.5	6.4	8.0
4	1.9	7.4	9.1
5	2.3	8.2	10.0
6	2.6	8.8	10.7

Conspicuously, the *NPRM* does not propose, or even discuss, *any* rule or other mechanism to manage the risk of aggregate interference from the earth stations of multiple NGSO systems.[19] And while a properly derived single-entry limit potentially could be used to mitigate the risk of such aggregate interference, the single-entry limit proposed in the *NPRM* is grossly inadequate for this purpose. That limit does not account for the significant evolution in GSO network design over the past twenty years. Instead, the *NPRM* simply assumes that a twenty-year old ITU-R limit developed in a very different context is appropriate to protect today's high-throughput GSO satellites. It is not. Moreover, any attempt to use a single-entry limit for this purpose necessarily would need to be based on apportioning to each NGSO system just some of the aggregate EPFD permitted to be generated toward any given GSO network by multiple co-channel NGSO system operations.[20]

Notably, the -162 dBW/(m^2 * 40 kHz) uplink EPFD limit proposed in the *NPRM* is based on Table 22-2 of the ITU Radio Regulations, which was initially adopted at WRC-2000, and was

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18 This representative analysis includes fewer than all of the proposed NGSO systems because it seems unlikely that each and every one of those systems would simultaneously contribute co-channel interference into a given GSO beam. The appropriate number of NGSO systems to be considered for purposes of developing a suitable aggregate uplink EPFD limit requires further study.

19 ViaSat Comments at ii, 11-17.

20 *See id.*

last updated by WRC-03. The data template in Recommendation ITU-R S.1328-4 ("Satellite System Characteristics to Be Considered in Frequency Sharing Analyses Within the Fixed-Satellite Service," which was last updated in 2002) was intended to reflect GSO Ka-band satellite performance estimates during the WRC-03 preparatory process. But, as shown above, GSO satellite design and performance have since evolved significantly.

Indeed, each of ViaSat's in-orbit and planned high-throughput satellites was launched or designed *after* ITU-R S.1328-4 was developed. As noted above, ViaSat-1 was launched in 2011, ViaSat's second-generation broadband satellite is expected to be launched next month, and its third-generation broadband satellite is expected to be launched in 2019. Each of those spacecraft performs at levels of spectral efficiency that are well beyond those assumed in developing that 2002 ITU-R recommendation. Thus, regardless of whether "the U.S. GSO FSS community participated actively" in the development of the Article 22 EPFD limits in the 1998-2002 timeframe,[21] it should be clear that ViaSat did not (as it was not even a satellite broadband provider at the time). Moreover, because ViaSat has driven the improvements in GSO network performance over the past six years, its interests were not otherwise represented in the ITU process conducted long ago.

In any event, based on the analysis presented above, ViaSat calculates that the single-entry uplink EPFD limit must be no more than -174 dBW/m^2 in a 40 kHz bandwidth to provide adequate protection to GSO networks operating in the Ka band. Even at this level, today's high-throughput GSO satellites would experience higher levels of uplink degradation than low-throughput GSO satellites would have experienced in 2003 if protected with the Article 22 EPFD limits. Nevertheless, the -174 dBW/m^2 limit would significantly reduce the adverse impacts of

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21 *See NPRM* ¶ 19.

NGSO operations on GSO networks, particularly as compared to the higher limit proposed in the *NPRM*.

B. Commenting Parties Fail To Account for the Significant Enforcement Challenges that Would Impede the Effectiveness of Proposed Uplink and Downlink EPFD Limits

As Inmarsat correctly observes, "currently there is no mechanism to ensure that *aggregate* EPFD limits will be met by all NGSO FSS systems licensed in a particular band."[22] Furthermore, as the Commission itself has recognized, there is no suitable methodology for apportioning aggregate EPFD "allowances" across various authorized NGSO FSS systems to ensure that GSO networks are adequately protected.[23] As ViaSat explained in its initial comments, there is no rule proposed in the *NPRM* governing the aggregate EPFD in the Earth-to-space (uplink) direction from all co-frequency earth stations of all authorized NGSO FSS systems. Nor is a mechanism proposed to ensure that suitable aggregate limits in the space-to-Earth, space-to-space, and Earth-to-space directions are honored and that critical GSO operations thus are protected. These omissions must be addressed,[24] and no commenting party has offered a solution. This issue is important with respect to both: (i) the aggregate *uplink* EPFD limits that still need to be developed; and (ii) the proposed aggregate *downlink* EPFD limits that may be adopted.

Challenges with respect to the enforcement of aggregate EPFD limits put additional pressure on the need to adopt and apply effective single-entry EPFD limits in both the uplink and

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22 Inmarsat Comments at 8.

23 *See generally Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range*, 16 FCC Rcd 4096, at ¶ 107 (2000) (discussing difficulties of ensuring compliance with aggregate EPFD limits) ("*Ku-Band EPFD Order*").

24 ViaSat Comments at 15.

the downlink directions. Notably, the ITU-R single-entry limits were derived from an aggregate EPFD mask that was developed first, under the assumption that 3.5 NGSO systems would be able to share spectrum in a given band segment.[25] More specifically, single-entry limits were designed to ensure that combined interference from those 3.5 NGSO systems would not exceed tolerable levels (as reflected in that aggregate EPFD mask).[26]

The "3.5 network" assumption was grounded in technical analysis conducted in the 1999-2000 timeframe regarding the number of *NGSO* satellites that could operate simultaneously without causing prohibitive levels of self-interference. There simply is no basis for continued use of that assumption today. Indeed, in the current Ka-band processing round, the Commission is faced with the possibility of either licensing or granting United States market access to *eleven* NGSO FSS systems with over 5,600 spacecraft, many of which systems could contribute to the aggregate EPFD received by any given GSO FSS network from co-channel NGSO FSS operations. The same situation exists with respect to the *nine* NGSO systems proposed in the current V-band processing round that would have over 17,000 spacecraft. Notably, applicants have proposed constellations that vary considerably in size, orbital parameters, coverage, and functionality, and that differ from the parameters underlying the technical analysis conducted twenty years ago. This is precisely why ViaSat, in commenting on the two Ka-band and V-band NGSO applications that already have appeared on Public Notice, urged the Commission to

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25 *See* International Telecommunication Union Radiocommunication Sector, *Conference Preparatory Meeting Report on technical, operational, and regulatory/procedural matters to be considered by the 2000 World Radiocommunication Conference*, § 3.1.1.2 (1999).

26 *Id.*

evaluate those proposals within the context of all of the other applications filed by the relevant cut-off dates.[27]

Three times as many NGSO system proposals currently are pending before the Commission than were anticipated when the Article 22 EPFD limits for parts of the Ka band were first developed. If nothing else, the larger number of networks would significantly increase the level of complexity inherent in the NGSO FSS operating environment and thus exacerbate the recognized difficulties associated with enforcing aggregate limits. Consequently, there is an indisputable need to derive new single-entry EPFD limits for all of the Ka band, and to establish single-entry EPFD limits for the V band, in each case that are calibrated to ensure that the aggregate EPFD from all proposed NGSO systems does not exceed tolerable limits[28]—consistent with Commission policy.[29]

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27 *See* Comments of ViaSat, Inc., IBFS File No. SAT-LOI-20160428-00041, at 1-2 & 7 (Aug. 15, 2016) ("OneWeb seeks waivers of certain Commission rules, including rules related to: (i) band splitting among NGSO applicants and (ii) protecting geostationary-orbit ("GSO") satellites from NGSO interference. . . . Thus, OneWeb's waiver requests cannot be considered in isolation. ViaSat therefore requests that the Commission defer consideration of those waiver requests, and the Petition more broadly, until interested parties have the opportunity to evaluate in full the operating environment that would result from all of the NGSO systems proposed by the November 15, 2016 close of the processing round. . . . Similarly, in order to evaluate whether GSO networks are fully protected, the Commission will need to evaluate the aggregate impact into GSO networks of all NGSO systems in the processing round.") (footnotes omitted); Comments of ViaSat, Inc., IBFS File No. SAT-LOA-20160622-00058, at 4 (Dec. 1, 2016) ("A full and complete analysis of the public interest considerations relevant to Boeing's waiver request requires concurrent consideration of those applications, particularly given the complexity of the shared spectrum environment inherent in the operations of multiple NGSO systems in the same spectrum.").

28 *See* Inmarsat Comments at 8.

29 *See Ku-Band EPFD Order* ¶ 106 (suggesting that an appropriate conversation factor must "take[] into account the way in which interference from multiple systems aggregates into a GSO FSS earth station antenna, recognizing that the interference is not strictly additive in a linear or power sense.").

C. Any Changes to the Default GSO/NGSO Spectrum-Sharing Rule Must Fully Protect GSO Networks and Also Ensure Reliable GSO Spectrum Access

The *NPRM* proposes to modify Section 25.156(d)(5) of the Commission's rules to make it easier for NGSO and GSO systems to share spectrum, subject to a broad requirement that NGSO systems protect GSO networks.[30] That rule currently provides that where the Commission has not yet adopted band-specific satellite service rules, the Commission will not consider an application seeking authority to operate an NGSO-like satellite network after it has granted an application for GSO-like operations in the same band segment, unless and until the Commission establishes NGSO-GSO sharing criteria for that frequency band segment—and *vice versa*.[31]

The Commission has not yet adopted band-specific satellite service rules for the 17.8-18.3 GHz, 27.5-28.35 GHz, 37.5-42.0 GHz, 47.2-50.2 GHz, or 50.4-51.4 GHz band segments.[32]

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30 *NPRM* ¶ 21.

31 47 C.F.R. § 25.156(d)(5). In adopting this provision, the Commission was clear that "priority" under this rule is determined by which type of application (GSO-like or NGSO-like) is filed first:

> "[I]f a GSO-like satellite system application is filed first, we will consider other GSO-like satellite system applications in the order they are filed, and we will dismiss subsequently-filed NGSO-like satellite system applications in that band until sharing criteria are established. This is consistent with our current practice. For example, in the Ku-band, we initially considered only GSO satellite applications because the first applications for licenses in that band were for GSO networks. We did not begin considering Ku-band NGSO applications until we had established sharing criteria for compatible services with GSO applicants in that band." *Amendment of the Commission's Space Station Licensing Rules and Policies*, First Report and Order, 18 FCC Rcd 10760, at ¶ 58 (2003).

32 The service rules regarding earth station operations in the 27.5-28.35 GHz and 37.5-40.0 GHz band segments address coexistence with terrestrial uses of this spectrum, not the operation of spacecraft. Section 25.145 addresses NGSO FSS licensing in the 18.3-20.2 GHz and 28.35-30.0 GHz band segments. *See* 47 C.F.R. § 25.145.

However, the Commission has granted applications for GSO-like operations,[33] as well as NGSO-like operations,[34] in all or part of these band segments (other than 50.4-51.4 GHz). The applications for previously authorized GSO and GSO/NGSO hybrid systems demonstrated the ability of both types of satellite systems to coexist in these band segments even in the absence of formal sharing criteria adopted by the Commission. These showings suggest that the proposed change in Section 25.156(d)(5) may be appropriate, provided there are adequate mechanisms in place to ensure that GSO networks are actually protected under real-world conditions.

The Satellite Industry Association notes that "[t]he proven success of co-frequency GSO and NGSO operations in the Ka-band demonstrates" that existing Section 25.156(d)(5) "is not necessary to enable sharing" and "cannot be justified."[35] However, the SIA does not address what terms are needed to ensure that spectrum can be shared without posing a risk to GSO operations. Nor does the *NPRM* clearly address this point. Therefore, while ViaSat agrees that it is possible for GSO and NGSO systems to share spectrum effectively under many circumstances, it remains unclear whether the eleven NGSO systems proposed in the pending Ka-band processing round, and the nine NGSO systems proposed in the pending V-band processing round, would be capable of doing so—particularly since the operating environment presented by the 5,627 Ka-band NGSO satellites and the 17,334 V-band NGSO satellites that have been

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33 *See, e.g., Inmarsat Mobile Networks, Inc.*, Order and Authorization and Declaratory Ruling, 30 FCC Rcd 2770, at ¶ 25 (2015); Stamp Grant, Hughes Network Systems, LLC, IBFS File No. SAT-LOA-20111223-00248 (Aug. 3, 2012); *Northrop Grumman Order*.

34 *See, e.g.*, O3b Limited, IBFS File Nos. SES-LIC-20100723-00952 (granted Sept. 25, 2012); *Northrop Grumman Order.*

35 Comments of the Satellite Industry Association, IB Docket No. 16-408, at 8 (filed Feb. 27, 2017) ("SIA Comments"); *see also* OneWeb Comments at 25 (allowing co-frequency spectrum access for both GSO and NGSO systems would "allow innovative NGSO FSS systems to have access to critical spectrum resources without increasing the likelihood of interference to any incumbent GSO operations.").

proposed would be far different from the situation that exists today, or that ever has been considered previously.

The feasibility of such coexistence ultimately will turn on whether and how NGSO systems actually protect GSO networks—including by complying with appropriate EPFD limits that are still to be developed, and the need to take into account the considerations outlined above in Sections II.A and II.B. The *NPRM* suggests, but does not explicitly state, that compliance with any EPFD limits that the Commission adopts would be the sole mechanism for assessing whether GSO FSS networks are protected from harmful interference resulting from NGSO FSS operations under revised Section 25.156(d)(5).[36] If that is the Commission's intent, any EPFD limits incorporated into the revised rules would need to be designed to provide the requisite protection to GSO networks, and suitable EPFD limits also would need to be adopted for the V band—something that has not even been proposed in this proceeding.

If the Commission instead intends to rely on the general terms of No. 22.2 of the ITU Radio Regulations in modifying existing Section 25.156(d)(5) and applying the revised rule—without reference to any specific EPFD limits—that should be made expressly clear. In that case, it would be essential that the consideration of the nine NGSO applications and 17,334 satellites proposed in the pending V-band processing round include a full assessment of their aggregate impact on the operation of the GSO spacecraft being planned for the V-band.

In any event, Boeing stands alone in opposing the Commission's proposal to substitute a rule similar to No. 22.2 of the ITU Radio Regulations. Boeing instead asks the Commission to conclude that, in those bands where service rules have not yet been adopted, "no presumption

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[36] *NPRM* ¶ 19 n.52 ("We intend that compliance with EPFD limits in the Ka-band would satisfy any obligation on an NGSO FSS system to operate on a non-interference basis with respect to a GSO FSS networks.").

exists regarding whether GSO or NGSO FSS networks will have sharing priority . . . ."[37] But that presumption already *does* exist today and extends directly from the text of No. 22.2 itself: "Non-geostationary-satellite systems shall not cause unacceptable interference to and, unless otherwise specified in these Regulations, shall not claim protection from geostationary satellite networks in the fixed-satellite service and the broadcasting-satellite service operating in accordance with these Regulations. No. 5.43A does not apply in this case."

Boeing mischaracterizes Commission precedent when it claims that there is a "long standing recognition by the Commission of the need for FSS allocations that are primarily for NGSO use."[38] To the contrary, as far back as 1998 a number of satellite commenters explained that it would be "premature to divide the [V band] further for GSO or NGSO operations because not enough is known about the services that may be proposed in these bands."[39] In response, the Commission expressly concluded: "Based on our review of the record, we agree with those commenters arguing that it would be premature to make separate GSO and NGSO designations now."[40]

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37 Boeing Comments at 12.

38 *Id.* (incorrectly referencing *Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz, and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations*, 13 FCC Rcd 24649, at ¶ 22 (1998) ("*V-Band Report and Order*")).

39 *V-Band Report and Order* ¶ 20.

40 *Id*. at ¶ 21.

III. COMMENTING PARTIES FAIL TO ADDRESS HOW ASSIGNING SPECTRUM IN RELIANCE ON THE "AVOIDANCE OF IN-LINE INTERFERENCE" MECHANISM WOULD ADVERSELY IMPACT SERVICE BY COMPETING NGSO SYSTEMS

A number of commenting parties support the Commission's proposal to use the "avoidance of in-line interference" mechanism to assign spectrum to applicants in the pending Ka-band and V-band processing rounds, claiming that this approach would facilitate coexistence by NGSO systems in the same spectrum. For example, SpaceX asserts that the mechanism would permit NGSO FSS systems to operate throughout their authorized bands except during in-line events, and therefore characterizes the mechanism as the "best methodology for intra-service spectrum sharing" and asserts that it is "much preferable to a simple spectrum splitting approach . . . ."[41] Boeing and Lockheed make similar claims, with Boeing advocating the use of this approach in both the Ka and V bands.[42]

Significantly, these parties fail to account for the ways in which reliance on the "avoidance of in-line interference" mechanism in awarding spectrum would actually *harm* the ability of competitive NGSO systems to operate effectively. Notably, in-line events are likely to be far more common than most parties acknowledge—with devastating implications for the coverage and capacity of NGSO FSS systems that are much smaller than, for example: (i) the 11,943-satellite V-band SpaceX system; (ii) the 4,425-satellite Ka-band SpaceX system; (iii) the 2,956-satellite V-band Boeing system; (iv) the 2,000-satellite V-band OneWeb system; and (v) the 720-satellite Ka-band OneWeb system. And efforts to minimize the frequency of in-line

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41 SpaceX Comments at 18.

42 *See, e.g.*, Boeing Comments at 12; Comments of Lockheed Martin Corporation, IB Docket No. 16-408, at 2 (filed Feb. 27, 2017).

events are themselves likely to limit the benefits derived from the NGSO FSS operations of the competitors of SpaceX, Boeing, and OneWeb, as discussed below.

A. Relying on the "Avoidance of In-Line Interference" Mechanism to Assign Spectrum Would Impede Effective Competition

As the *NPRM* acknowledges, using the "avoidance of in-line interference" mechanism would require a transmitting NGSO system operator to cease or limit its transmissions whenever an in-line event occurs.[43] Therefore, the utility of the mechanism depends largely on such in-line interference events being relatively uncommon; where such events are common, they present uncertainty and operational complexity, and also can have a dramatic adverse impact on how certain NGSO constellations would operate.[44] Indeed, as Telesat Canada notes, there already are significant challenges in determining when in-line events occur—with the resulting uncertainty having adverse implications for investment incentives.[45] These challenges would be exacerbated if in-line events were expected to occur frequently.

Given the eleven NGSO FSS systems with 5,627 spacecraft proposed in the Ka-band processing round, and the nine NGSO systems with 17,334 spacecraft proposed in the current V-band processing round, it should be quite apparent that in-line events would *not* be rare. Indeed, a preliminary analysis by ViaSat estimated that in-line events between the 2,956-satellite Boeing V-band system and the 24 satellite VIASAT-NGSO system would occur 46.7 percent of the time.[46] Any requirement for ViaSat's competitive NGSO system to avoid these in-line events

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43 *NPRM* ¶ 22.

44 ViaSat Comments at 19-20; *see also* 47 C.F.R. § 25.261.

45 Comments of Telesat Canada, IB Docket No. 16-408, at 11-14 (filed Feb. 27, 2017) ("Telesat Canada Comments").

46 Comments of ViaSat, Inc., IBFS File No. SAT-LOA-20160622-00058, at 3 and Ex. A (Dec. 1, 2016). That preliminary analysis is based on applying Section 25.261 of the

would result in significant adverse consequences for the service quality and price that ViaSat could offer to consumers.[47] This problem would be exacerbated by any need to avoid the frequent in-line events caused by the operation of each of the 11,943-satellite SpaceX system, the 4,425-satellite SpaceX system, the 2,000-satellite OneWeb system, and the 720-satellite OneWeb system.

Notably, the impact of the "avoidance of in-line interference" mechanism on any given NGSO FSS operator is directly related to the size of that operator's constellation, relative to the size of its competitors. Where one operator utilizes a relatively large constellation with a high degree of satellite diversity, in-line events should not significantly impact the coverage or capacity of the network because alternative transmission paths should be available for its use. As such, it should come as no surprise that operators like SpaceX, Boeing, and OneWeb—each of which plans to launch many thousands of satellites—support spectrum assignments that rely on the "avoidance of in-line interference" mechanism. After all, such an approach to spectrum access would provide them with the ability to access significant swaths of spectrum while compelling their competitors to bear the burden of coexistence.

In contrast, where an operator utilizes a more modestly sized constellation, and has fewer opportunities to employ path diversity to overcome in-line events, relying on the "avoidance of in-line interference" mechanism as the basis for awarding spectrum would likely have a substantial adverse impact on coverage and capacity. Stated differently, relying on that

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Commission's rules (which addresses in-line interference events between NGSO FSS networks), which provides a reasonable proxy for evaluating the potential for co-frequency spectrum conflicts among different V-band NGSO systems.

47 ViaSat Comments at 20-23.

mechanism to award spectrum would disproportionately impact NGSO systems that utilize smaller constellations—such as ViaSat's NGSO system.

These dynamics are illustrated in ViaSat's initial comments, which demonstrate that: (i) the need to avoid Boeing's 2,956-satellite V-band NGSO system during in-line events would significantly reduce the average probability of a given location being covered by ViaSat's NGSO system at any given point in time, to less than 50 percent in large parts of the United States—while Boeing's coverage would not be materially impacted by the need to avoid the much smaller ViaSat system; and (ii) the need to avoid Boeing's system would significantly reduce the average number of ViaSat satellites visible from a given location at any point in time, and therefore significantly reduce the available capacity provided by the ViaSat NGSO system—while, again, Boeing's available capacity would hardly be impacted at all by the need to avoid ViaSat's NGSO system.[48]

These results are not unique to Boeing's V-band system. Indeed, reliance on the "avoidance of in-line interference" mechanism would allow any large-constellation NGSO system to force smaller systems to shoulder almost the entire burden of coexisting in the same spectrum, with highly inequitable results. This is reflected in the attached Exhibits 1A-D, 2A-D, and 3A-B, which depict how this very same problem would be created by the: (i) 11,943-satellite V-band SpaceX system; (ii) the 4,425-satellite Ka-band SpaceX system; (iii) the 2,000-satellite V-band OneWeb system; and (iv) the 720-satellite Ka-band OneWeb system. For completeness, Exhibits 1, 2 and 3 include data for the 2,956-satellite Boeing V-band system; for comparison they also depict the impact of the much smaller 117-satellite Ka-/V-band Telesat system, and the 84-satellite Ka-band LeoSat system.

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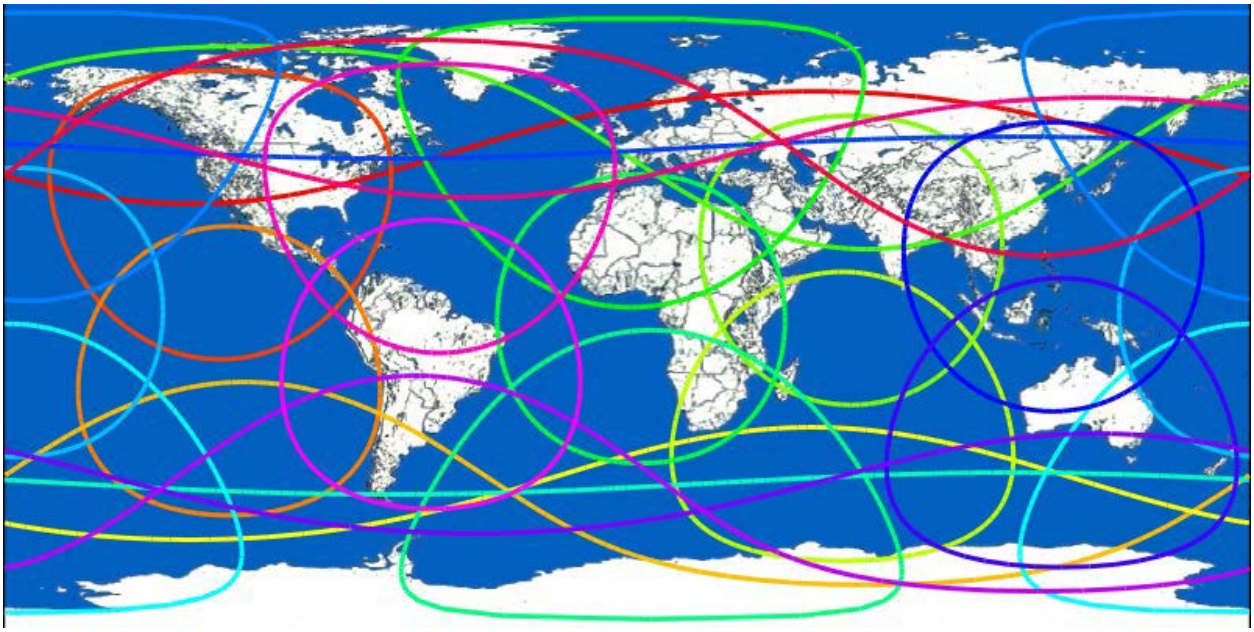
[48] ViaSat Comments at 20 & Ex. 1 and 2.

While the discussion below focuses on the impact on the provision of service to the contiguous United States (CONUS), it bears emphasis that ViaSat's NGSO system expressly is designed to satisfy the Commission's NGSO global coverage requirements,[49] and that its service area also includes Hawaii, Alaska, Puerto Rico, and the U.S. Virgin Islands, as well as the parts of the world depicted below:



Exhibits 1A, 1B, 1C, and 1D show that any need to avoid the much larger SpaceX, Boeing, or OneWeb systems during in-line events would significantly reduce the average probability of any given area being covered by ViaSat's NGSO system, while any need to avoid the Telesat system or the LeoSat system would have nominal impact, at most, on ViaSat. Notably, none of the other proposed NGSO systems would be materially affected by the need to avoid the ViaSat system. More specifically:

- ViaSat would have coverage at all latitudes within its service area *100 percent of the time*, absent the need to turn off to avoid other NGSO systems;

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[49] 47 C.F.R. § 25.145.

- Avoiding the much larger Ka-band SpaceX system would reduce the average probability of ViaSat's covering all of CONUS to *only 30 percent*, with some areas in CONUS covered *a mere 22 percent* of the time;

- Avoiding the much larger V-band SpaceX system would reduce the average probability of ViaSat's covering all of CONUS to *only 19 percent*, with some areas in CONUS covered *a mere 11 percent* of the time;

- Avoiding the much larger V-band Boeing system would reduce the average probability of ViaSat's covering all of CONUS to *only 47 percent*, with some areas in CONUS covered *a mere 37 percent* of the time; and

- Avoiding the much larger V-band OneWeb system would reduce the average probability of ViaSat's covering all of CONUS *to only 49 percent*, with some areas in CONUS covered *a mere 20 percent* of the time.

Exhibits 2A, 2B, 2C, and 2D show that any need to avoid the much larger SpaceX, Boeing, or OneWeb systems during in-line events would significant reduce the capacity available over ViaSat's NGSO system at any given location by reducing the average number of ViaSat satellites available for service, while (again) the Telesat and LeoSat systems would have a nominal impact, at most. Notably (again), none of the other proposed NGSO systems would be materially affected by the need to avoid the ViaSat system. More specifically:

- ViaSat would have, on average, *2.9 satellites* covering every location in CONUS, absent the need to turn off to avoid another NGSO system;

- Avoiding the much larger Ka-band SpaceX system would reduce the average number of ViaSat satellites available to serve a location in CONUS to *only 0.33 satellites*, with some locations in CONUS served by an average of *a mere 0.23 satellites*;

- Avoiding the much larger Ka-band OneWeb system would reduce the average number of ViaSat satellites available to serve a location in CONUS to *only 1.8 satellites*, with some locations in CONUS served by an average of *a mere 1.7 satellites*;

- Avoiding the much larger V-band SpaceX system would reduce the average number of ViaSat satellites available to serve a location in CONUS to *only 0.19 satellites*, with some locations in CONUS served by an average of *a mere 0.11 satellites*;

- Avoiding the much larger V-band Boeing system would reduce the average number of ViaSat satellites available to serve a location in CONUS to *only 0.53 satellites*, with some locations in CONUS served by an average of *a mere 0.43 satellites*; and

- Avoiding the much larger V-band OneWeb system would reduce the average number of ViaSat satellites available to serve a location in CONUS to *only 0.61 satellites*, with some locations in CONUS served by an average of *a mere 0.21 satellites*.

Exhibits 3A and 3B depict the average number of hours that a VIASAT-NGSO user in CONUS would not be able to receive service if ViaSat were required to turn off to avoid another NGSO system during in-line events. By way of reference, 99.9 percent availability would result in no more than 9 hours of outages per year, and 99.7 percent availability would result in no more than 27 hours of outages per year. In contrast, 400 hours of annual outages would yield an unacceptable 95 percent availability level, and 7,100 hours of annual outages would yield an abysmal 19 percent availability level. More specifically:

- ViaSat's NGSO satellite constellation is designed to provide—*100 percent of the time*, 8,760 hours per year—coverage to all of CONUS, absent the need to turn off to avoid another NGSO system;

- Avoiding the much larger Ka-band SpaceX system would reduce ViaSat's NGSO system average availability over CONUS by 6,118 hours per year, dropping availability to *only 30 percent*;

- Avoiding the much larger Ka-band OneWeb system would reduce ViaSat's NGSO system average availability over CONUS by 400 hours per year, dropping availability to *only 95.4 percent*;

- Avoiding the much larger V-band SpaceX system would reduce ViaSat's NGSO system average availability over CONUS by 7,100 hours per year, dropping availability to *only 19 percent*;

- Avoiding the much larger V-band Boeing system would reduce ViaSat's NGSO system average availability over CONUS by 4,600 hours per year, dropping availability to *only 47 percent*; and

- Avoiding the much larger V-band OneWeb system would reduce ViaSat's NGSO system average availability over CONUS by 4,400 hours per year, dropping availability to *only 49 percent*.

Notably, Exhibits 1A-D, 2A-D, and 3A-B consider the impact that each of the various NGSO systems *in isolation* could have on a relatively small constellation like ViaSat's. Just considered alone, any requirement to avoid in-line events with the co-frequency operations of any one of the systems described above could well prevent ViaSat from satisfying its obligations under Section 25.145 to be "capable of providing Fixed-Satellite Service on a continuous basis throughout the fifty states, Puerto Rico and the U.S. Virgin Islands."[50] The aggregate effects of *multiple* NGSO systems operating simultaneously in the same spectrum would be even more significant.

For these reasons, the Commission must consider a band-segmentation approach in the current Ka- and V-band NGSO processing rounds. Otherwise, certain operators would enjoy significant competitive advantages simply because they would deploy large constellations that have preclusive impacts on much smaller NGSO systems. Certainly, nothing should preclude spectrum coordination among operators that enables them to share additional spectrum after reaching mutually agreeable means of avoiding in-line interference events.

B. The In-Line Event "Trigger" Angle Should Not Be Changed

The *NPRM* invites comment as to whether to reduce the "trigger" angle used to define when an in-line event has occurred.[51] In response, a number of parties propose a variety of ways in which that angle might be reduced. For example, LeoSat proposes to reduce the angle to 2-3 degrees.[52] Kepler advocates the use of coordination to determine the angular separation

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50 47 C.F.R. § 25.145.

51 *NPRM* ¶ 26.

52 LeoSat Comments at 12.

threshold to be used by particular sets of operators.[53] SES and O3b propose reducing the angle to an unspecified level.[54] Space Norway recommends that any change to the angle be grounded in studies.[55] Boeing advocates the use of different angles in different circumstances, without explaining what differences would matter for these purposes.[56] Although the specifics vary, each of these parties assumes that reducing the trigger angle would be beneficial, without establishing as much with any objective data.

As ViaSat noted in its initial comments, the manner in which the trigger angle is defined can have a significant impact on the coverage and capacity issues described above.[57] Although reducing the trigger angle could mitigate, but not eliminate, those issues, it also would create different issues. Because the trigger angle reflects the degree of angular separation deemed necessary to avoid harmful interference between NGSO systems, any reduction in the angle requires some substitute mechanism to mitigate the possibility of harmful interference (*e.g.*, more restrictive antenna pointing, off-axis EIRP masks, or other earth station performance requirements), which itself could significantly and adversely impact how operators are able to design their networks and what services those networks are able to support. For example, such mechanisms could effectively preclude the use of NGSO systems for services that employ small mobile terminals. As these applications are likely to be of great benefit to the public, and

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53 Kepler Comments at 4.

54 SES/O3b Comments at 25.

55 Space Norway Comments at 12.

56 Boeing Comments at 12-13.

57 ViaSat Comments at 21.

consistent with SpaceX's advocacy on this point,[58] ViaSat again urges the Commission not to reduce the trigger angle.

Notably, it is not even necessary to consider changing the trigger angle if the band-splitting approach for spectrum assignment is employed. Rather, in such a case, parties could engage in coordination with respect to in-line events and trigger angles, and thus consider on a commercial basis the trade-offs associated with any corresponding and mutually agreeable antenna pointing, off-axis EIRP masks, or other earth station performance requirements that may be appropriate to enable them to share spectrum with each other.

IV. THE COMMISSION SHOULD NOT COUNTENANCE THE EFFORTS OF SOME PARTIES TO USE THIS PROCEEDING TO PROVIDE COVER FOR THEIR PENDING, NON-COMPLIANT NGSO APPLICATIONS

As the Commission is no doubt aware, in their applications for NGSO operating authority in the pending Ka- and V-band processing rounds, several commenters have sought waivers of the Commission's baseline licensing rules and application requirements for NGSO systems. For example, Boeing and SpaceX seek waivers of the Commission's milestone requirement to allow them to deploy only part of their constellations within the current and longstanding six-year NGSO deployment deadline.[59] O3b, SpaceX, and Boeing seek waivers of the current and long-

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58 SpaceX supports retaining the existing 10-degree "trigger" angle to avoid the imposition of additional performance requirements on NGSO FSS earth stations. SpaceX Comments at 20.

59 *See* The Boeing Company, IBFS File No. SAT-LOA-20160622-00058, Narrative at 72 (filed June 22, 2016) ("Boeing V-band Application"); The Boeing Company, IBFS File No. SAT-LOA-20161115-00109, Narrative at 28-29 (filed Nov. 15, 2016) ("Boeing Ka-band Application"); Space Exploration Holdings, LLC, IBFS File No. SAT-LOA-20170301-00027, Waiver Requests at 15-16 (filed Mar. 1, 2017) ("SpaceX V-Band Application"); Space Exploration Holdings, LLC, IBFS File No. SAT-LOA-20161115-00118, Waiver Requests at 8-10 (filed Nov. 15, 2016) ("SpaceX Ka-Band Application").

standing NGSO global coverage requirement.[60] And Boeing, Kepler, LeoSat, SpaceX, Telesat Canada, O3b and OneWeb seek waivers of the current and longstanding band segmentation provisions set forth in Section 25.157 of the Commission's rules.[61]

In other words, SpaceX, Boeing, and O3b have applied for system designs that do not comply with longstanding FCC application requirements and baseline processing round qualifications, and now seek to overcome their fundamental deficiencies, and avoid the risk of dismissal, through improper and inequitable post-cutoff notice rule changes. This would be an irrational and legally unsustainable result. It would reward those applicants for proposing non-compliant systems, while effectively handicapping those applicants that responsibly designed and proposed networks that comply with the Commission's existing rules in the first instance—rules that were not even *proposed* when the processing rounds were opened. And doing so would place the risk and burden associated with the proposed NGSO co-existence rules on applicants that filed compliant applications well before this proceeding ever started.

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60 *See* O3b Limited Ka-Band Application, IBFS File Nos. SAT-AMD-20161115-00116, Narrative at 9-10 (filed Nov. 15, 2016); O3b Limited, IBFS File No. SAT-AMD-20170301-00026, Narrative at 8 (filed Mar. 1, 2017) ("O3b V-Band Application"); SpaceX Ka-Band Application, Waiver Requests at 13-14; SpaceX V-Band Application, Waiver Requests at 9-10; Boeing V-Band Application, Narrative at 65; Boeing Ka-Band Application, Narrative at 28-29; Space Norway AS, IBFS File No. SAT-LOI-20161115-00111, Petition at 11-12 (filed Nov. 15, 2016).

61 Boeing V-Band Application, Narrative at 69; The Boeing Company, IBFS File No. SAT-LOA-20161115-00109 (filed Nov. 15, 2016); Kepler Communications Inc., IBFS File No. SAT-LOI-20161115-00114, Legal Narrative at 12-13 (filed Nov. 15, 2016); LeoSat MA, Inc., IBFS File No. SAT-LOI-20161115-00112, Petition at 14-15 (filed Nov. 15, 2016); SpaceX Ka-Band Application, Waiver Requests at 5-7; SpaceX V-Band Application, Waiver Requests at 12-14; Telesat Canada, IBFS File No. SAT-LOI-20161115-00108, Petition at 32-33 (filed Nov. 15, 2016); Telesat Canada, IBFS File No. SAT-LOI-20170301-00023, Petition at 27-28 (filed Mar. 1, 2017); O3b V-Band Application, Narrative at 10; WorldVu Satellites Limited (d/b/a OneWeb), IBFS File No. SAT-LOI-20160428-00041, Legal Narrative at 17-21 (filed Apr. 28, 2016); WorldVu Satellites Limited (d/b/a OneWeb), IBFS File No. SAT-LOI-20170301-00031, Legal Narrative at 28-30 (filed Mar. 1, 2017).

Notably, at this late date applicants that have not filed waiver requests could be unable to take advantage of any flexibility afforded by changes to the global coverage rule; doing so likely would require a major amendment to a pending application, which generally is not permitted outside of a designated filing window.[62] Moreover, modifying a pending application so that one could take advantage of new rules by employing a fundamentally different NGSO constellation with a different orbital architecture could require new ITU filings as well, and therefore affect matters that are outside the Commission's jurisdiction.

Fundamental fairness mandates equitable treatment of all applicants in the pending processing rounds. By allowing only some applicants to sidestep the requirements of rules that existed at the start of the relevant processing round, the Commission would grant unfair advantages to those applicants—both competitively and in subsequent coordination negotiations. If the Commission nevertheless decides to implement fundamental changes to its NGSO licensing framework, as proposed in the *NPRM*, the most sensible approach would be to dismiss all pending NGSO applications (without prejudice to refiling), initiate new Ka- and V-band

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62 47 C.F.R. § 25.116(c). The V-band and Ka-band cut-off notice indicate that the Commission will provide applicants who filed by the relevant cut-off dates "an opportunity to amend their requests, if necessary, to conform to any requirements or policies that may be subsequently adopted concerning NGSO-like satellite operation in these bands." *See Satellite Policy Branch Information, OneWeb Petition Accepted for Filing, IBFS File No. SAT-LOI-20160428-00041, Cut-Off Established for Additional NGSO-Like Satellite Applications or Petitions for Operations in the 10.7-12.7 GHz, 14.0-14.5 GHz, 17.8-18.6 GHz, 18.8-19.3 GHz, 27.5-28.35 GHz, 28.35-29.1 GHz, and 29.5-30.0 GHz Bands*, Public Notice, DA 16-804, at 2 (July 15, 2016); Satellite Policy Branch Information, Boeing Application Accepted for Filing in Part, IBFS File No. SAT-LOA-20160622-00058, Cut-Off Established for Additional NGSO-Like Satellite Applications or Petitions for Operations in the 37.5-40.0 GHz, 40.0-42.0 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz Bands, Public Notice, DA 16-1244, at 3 (Nov. 1, 2016). Those statements do not expressly allow *discretionary* changes made possible by subsequent rule and policy changes.

processing rounds *after* this proceeding has been fully resolved (and new rules are enacted), and allow all operators to avail themselves of the new rules.

V. CONCLUSION

For the reasons set forth above and in ViaSat's initial comments, the Commission should license NGSO systems in a manner that preserves the integrity of the Commission's rules, facilitates the ability of NGSO systems to share limited spectrum resources with GSO networks, and ensures that smaller NGSO systems are not forced to coexist in the same spectrum as much larger NGSO systems, and bear capacity, coverage, and service level reductions that the much larger systems would not bear. To achieve these objectives, ViaSat recommends that the Commission:

(i) Adopt both single-entry and aggregate EPFD limits specifically designed to protect today's high-throughput GSO networks from harmful interference resulting from the significant number of NGSO systems proposed in the pending Ka-band and V-band processing rounds;

(ii) Develop a mechanism to ensure that suitable aggregate EPFD limits in the space-to-Earth, space-to-space, and Earth-to-space directions are honored and that critical GSO operations thus are protected;

(iii) Utilize "band-splitting" to assign access to specific band segments to each NGSO system, instead of requiring applicants to rely on the "avoidance of in-line interference" mechanism, and allow coordination among NGSO operators to provide them the ability to access additional spectrum based on mutually agreeable sharing techniques; and

(iv) Dismiss all pending Ka- and V-band NGSO applications (without prejudice to refiling) and initiate new processing rounds *after* this proceeding has been fully resolved and after any fundamental changes in the rules for licensing NGSO systems are implemented, to avoid otherwise providing impermissible advantages to those applicants that have proposed systems that do not satisfy longstanding FCC application requirements and baseline processing round qualifications.

Respectfully submitted,

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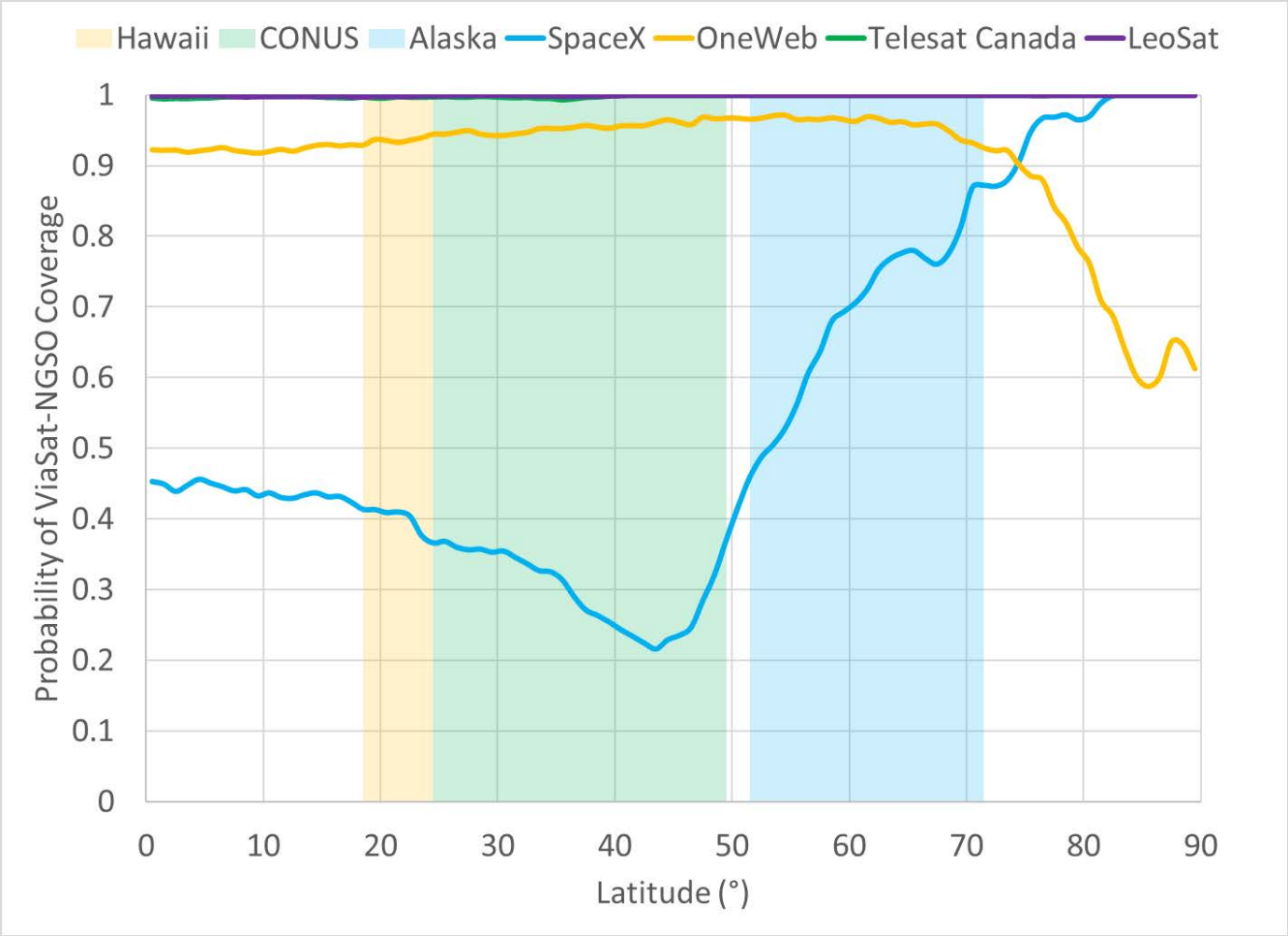
April 10, 2017

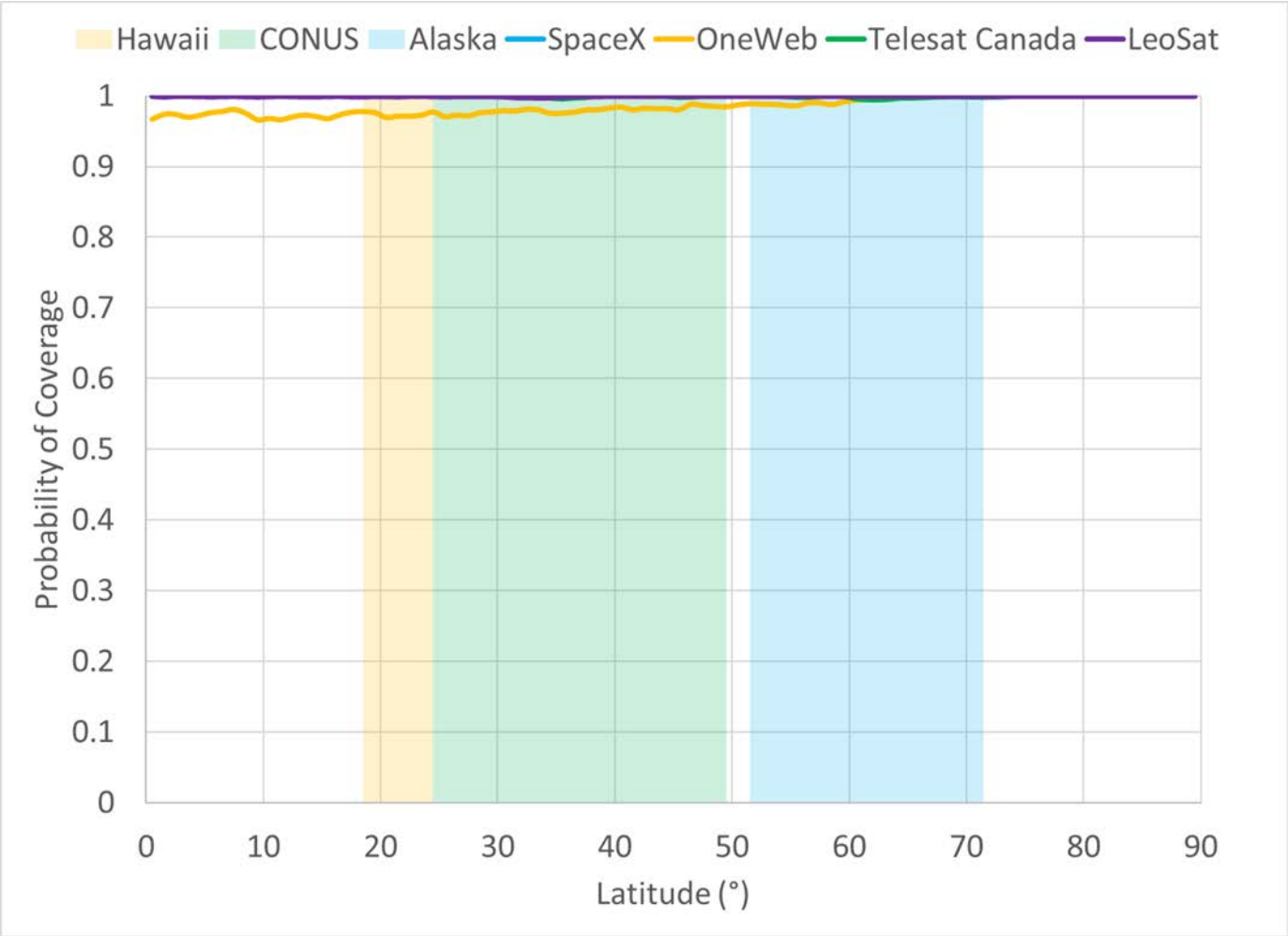
EXHIBITS

Exhibit 1A
Ka Band: Average Coverage Probability Loss for ViaSat-NGSO from Its Avoiding In-Line Events with Other NGSOs (By Latitude)



Note: Loss caused by Telesat Canada and by LeoSat is barely visible on the scale.

Exhibit 1B
Ka Band: Average Coverage Probability Effect on Other NGSOs from Their Avoiding In-Line Events with ViaSat (By Latitude)



Note: Effect on SpaceX, Telesat Canada, and LeoSat is barely visible on the scale.

Exhibit 1C
V Band: Average Coverage Probability Loss for ViaSat-NGSO from Its Avoiding In-Line Events with Other NGSOs (By Latitude)

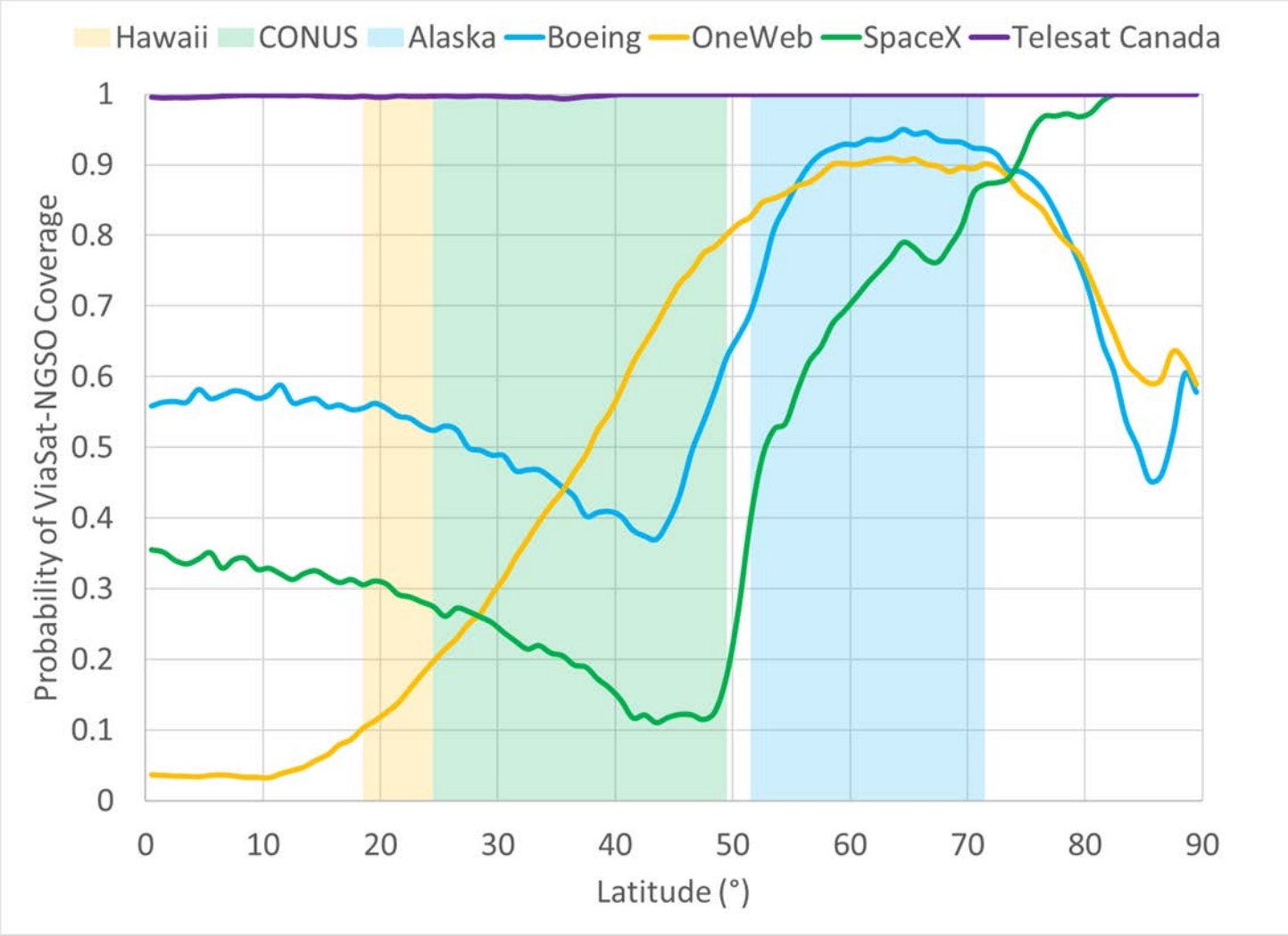
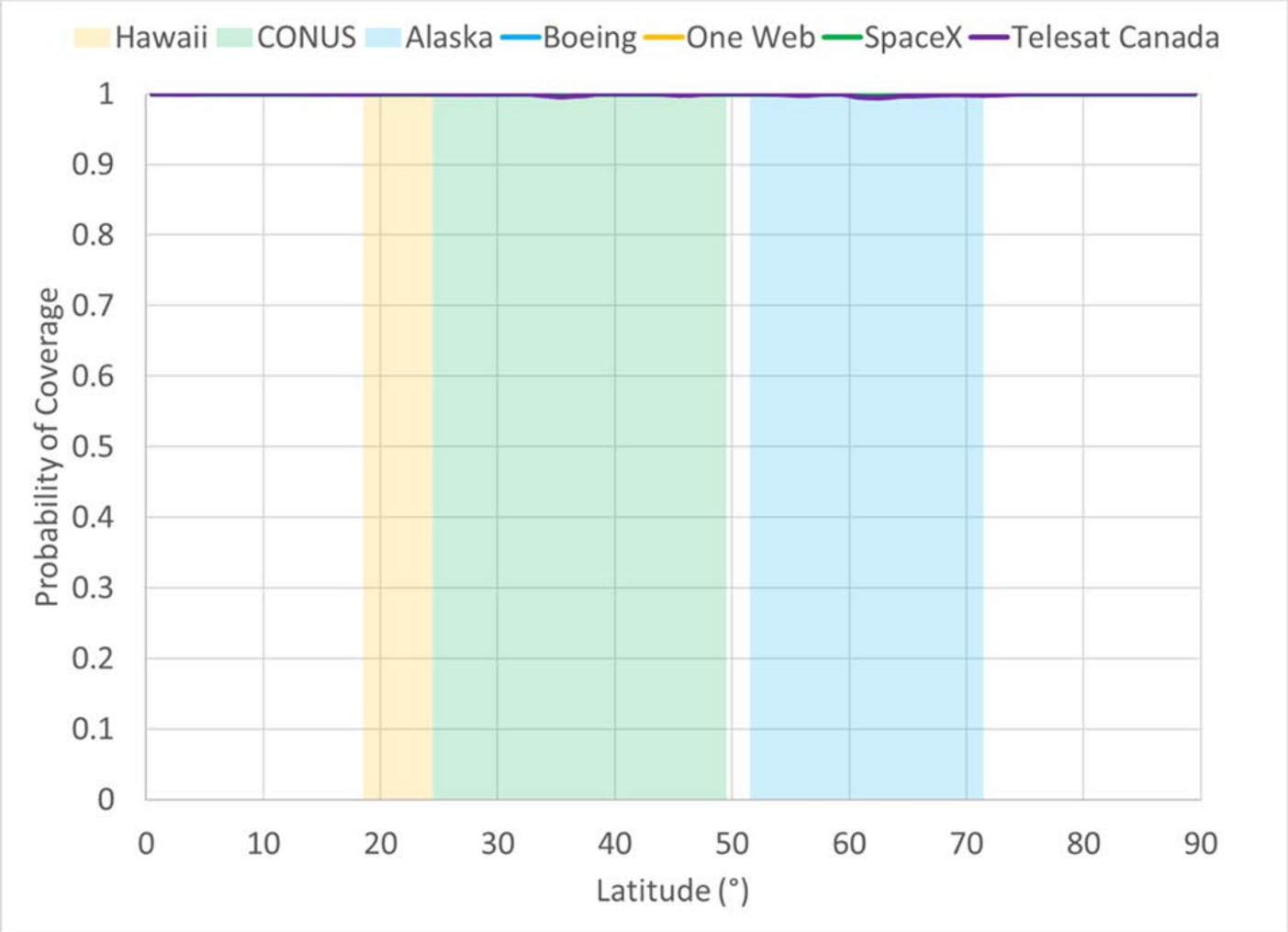


Exhibit 1D
V Band: Average Coverage Probability Effect on Other NGSOs from Their Avoiding In-Line Events with ViaSat (By Latitude)



Note: Effect on Boeing, OneWeb, SpaceX and Telesat Canada is barely visible on the scale.

Exhibit 2A
Ka Band: Average Capacity Loss for ViaSat-NGSO from Its Avoiding In-Line Events with Other NGSOs (By Latitude)

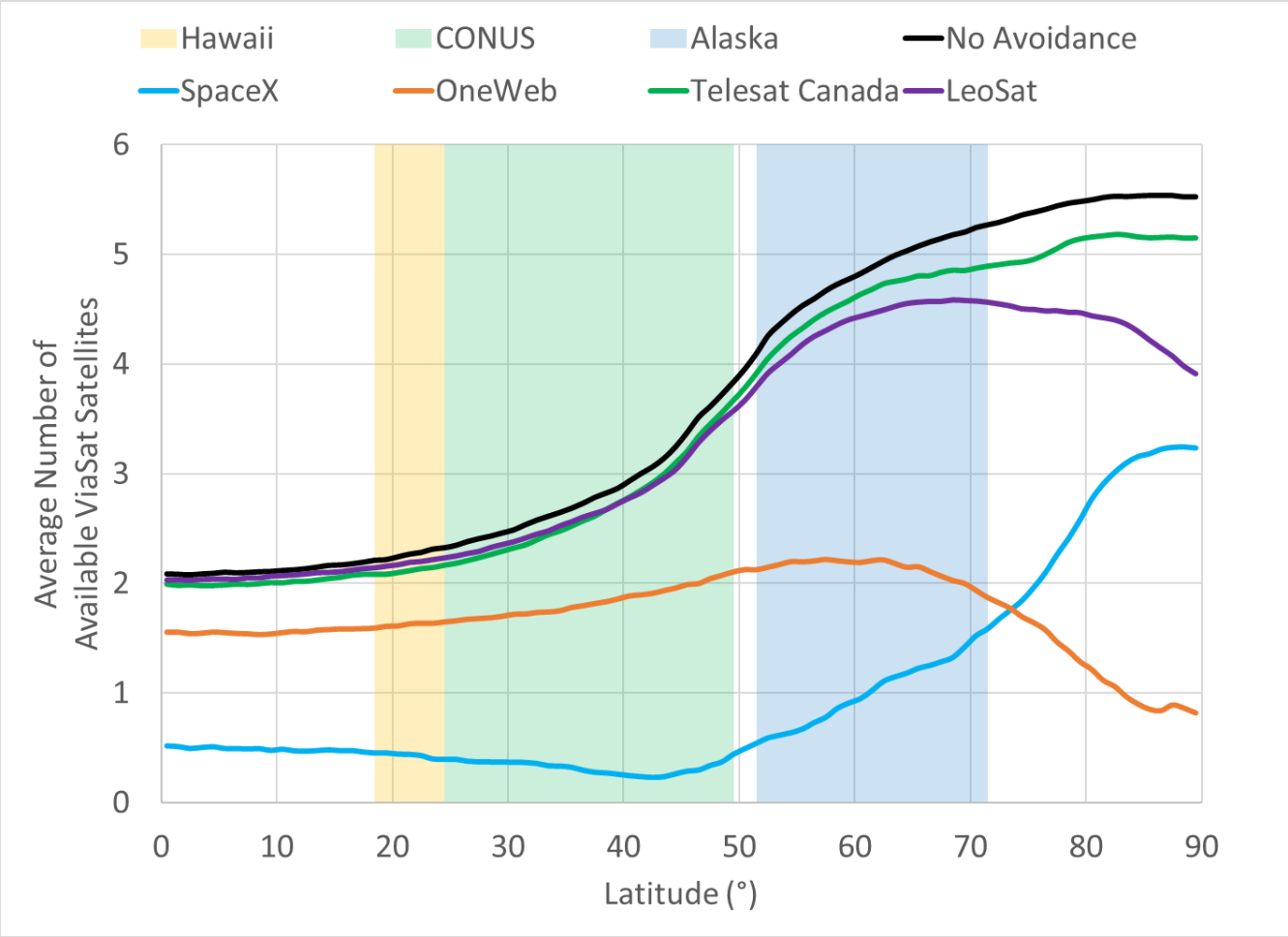


Exhibit 2B
Ka Band: Average Capacity Effect on Other NGSOs
from Their Avoiding In-Line Events with ViaSat
(By Latitude)

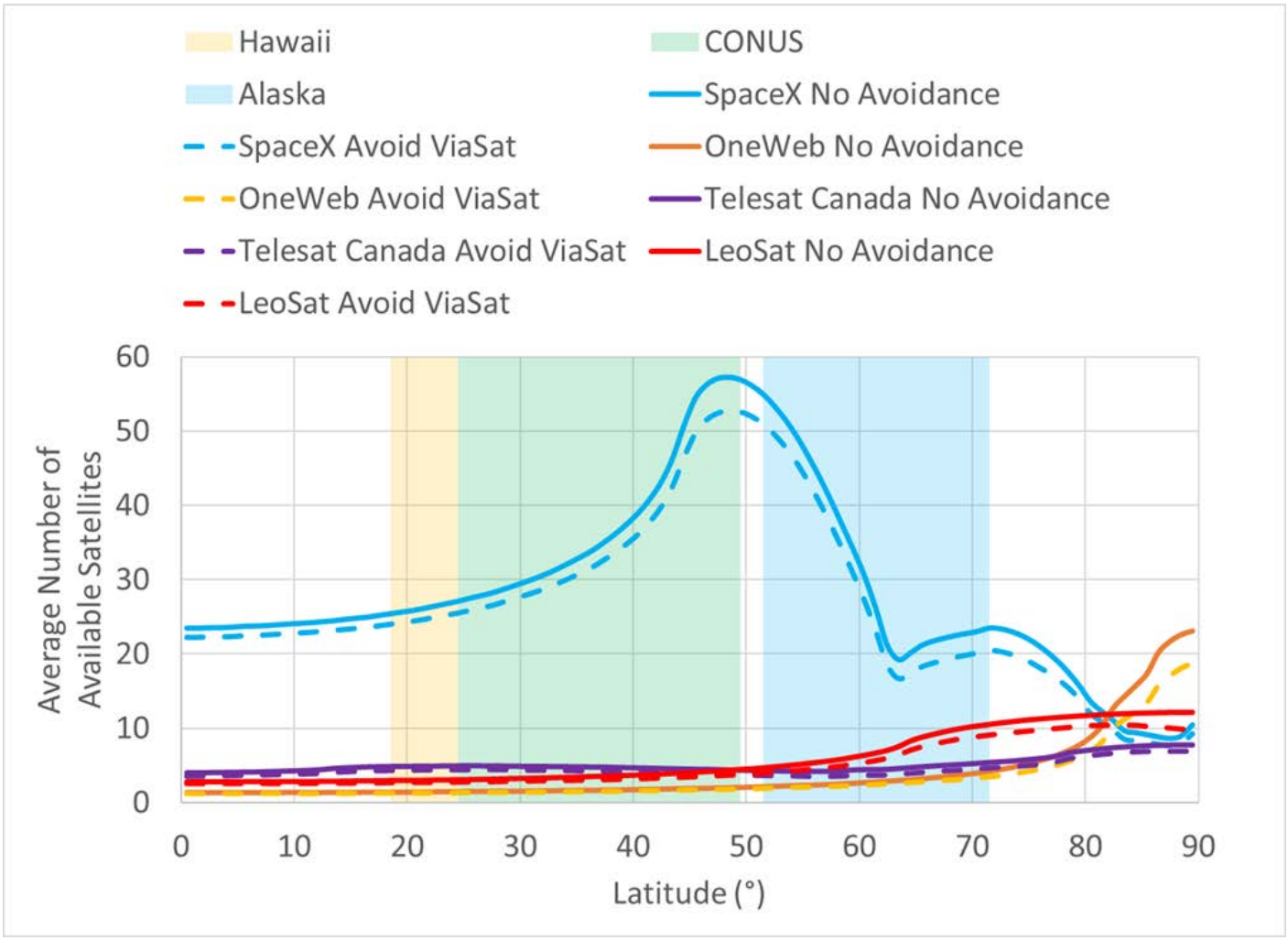


Exhibit 2C
V Band: Average Capacity Loss For ViaSat-NGSO from Its Avoiding In-Line Events with Other NGSOs (By Latitude)

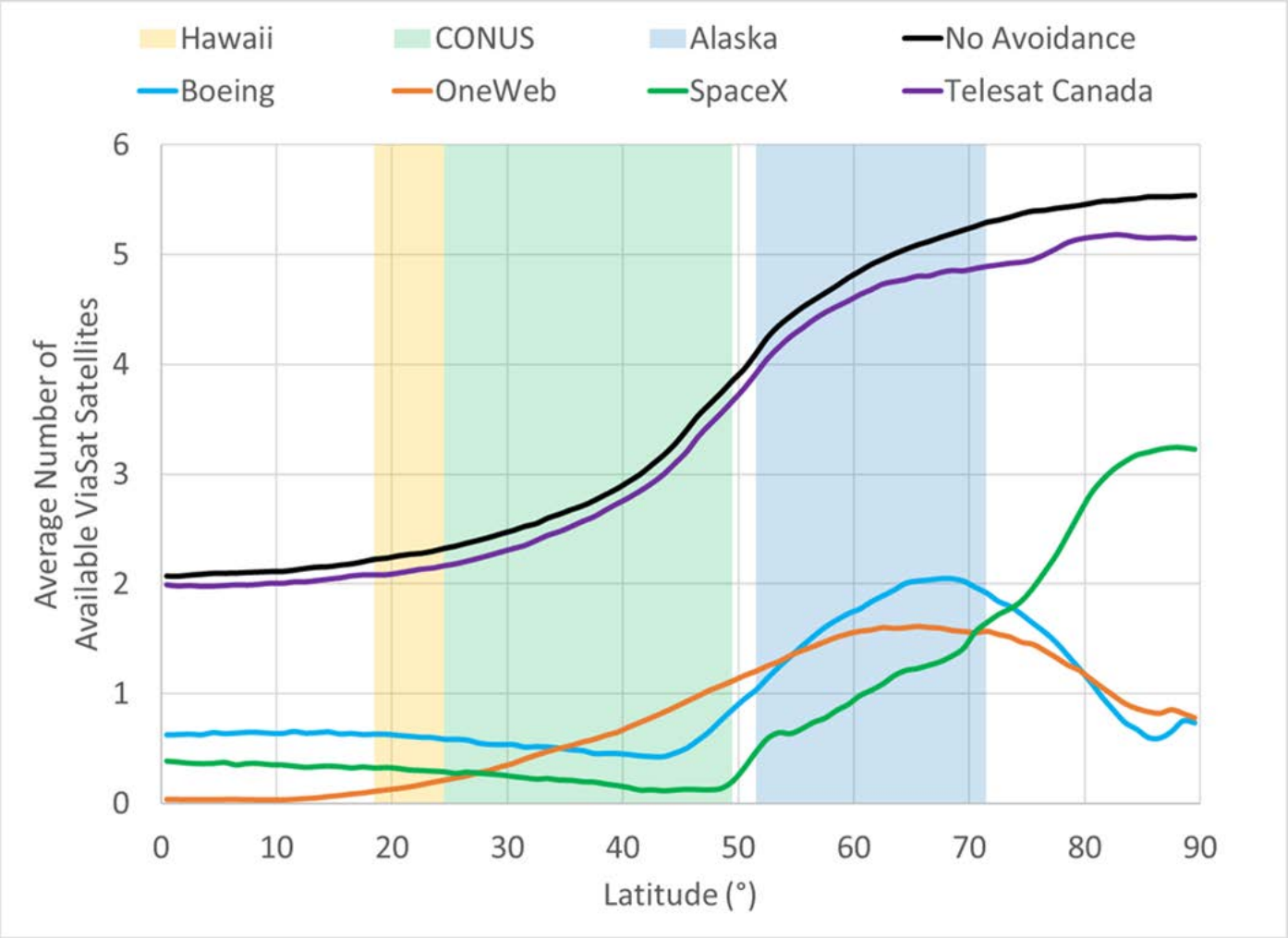


Exhibit 2D
V Band: Average Capacity Effect On Other NGSOs from Their Avoiding In-Line Events with ViaSat (By Latitude)

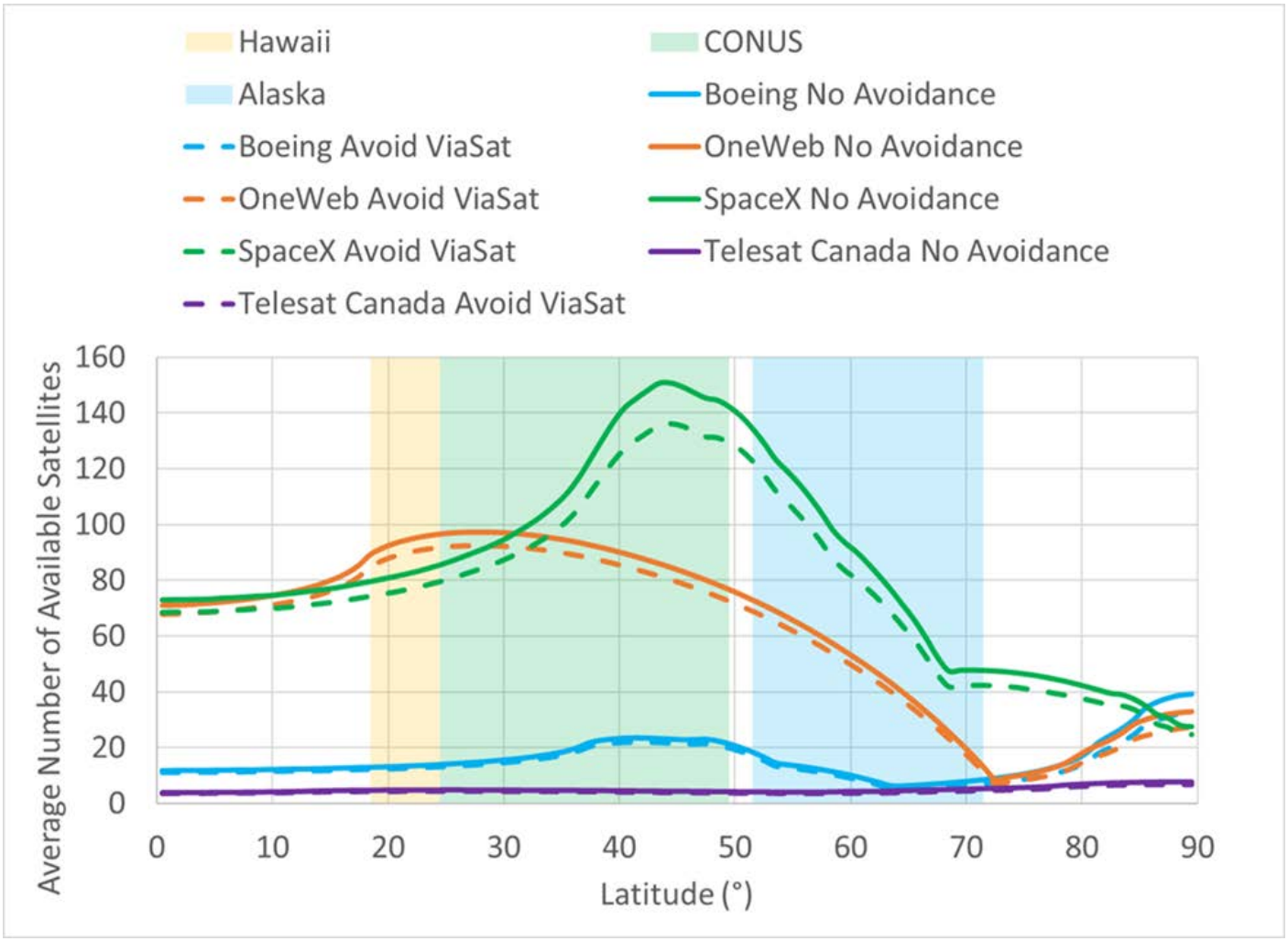


Exhibit 3A
Ka Band: Average Outage Hours Per Year For ViaSat-NGSO from Its Avoiding In-Line Events with Other NGSOs (From 0º to 90º Latitude)

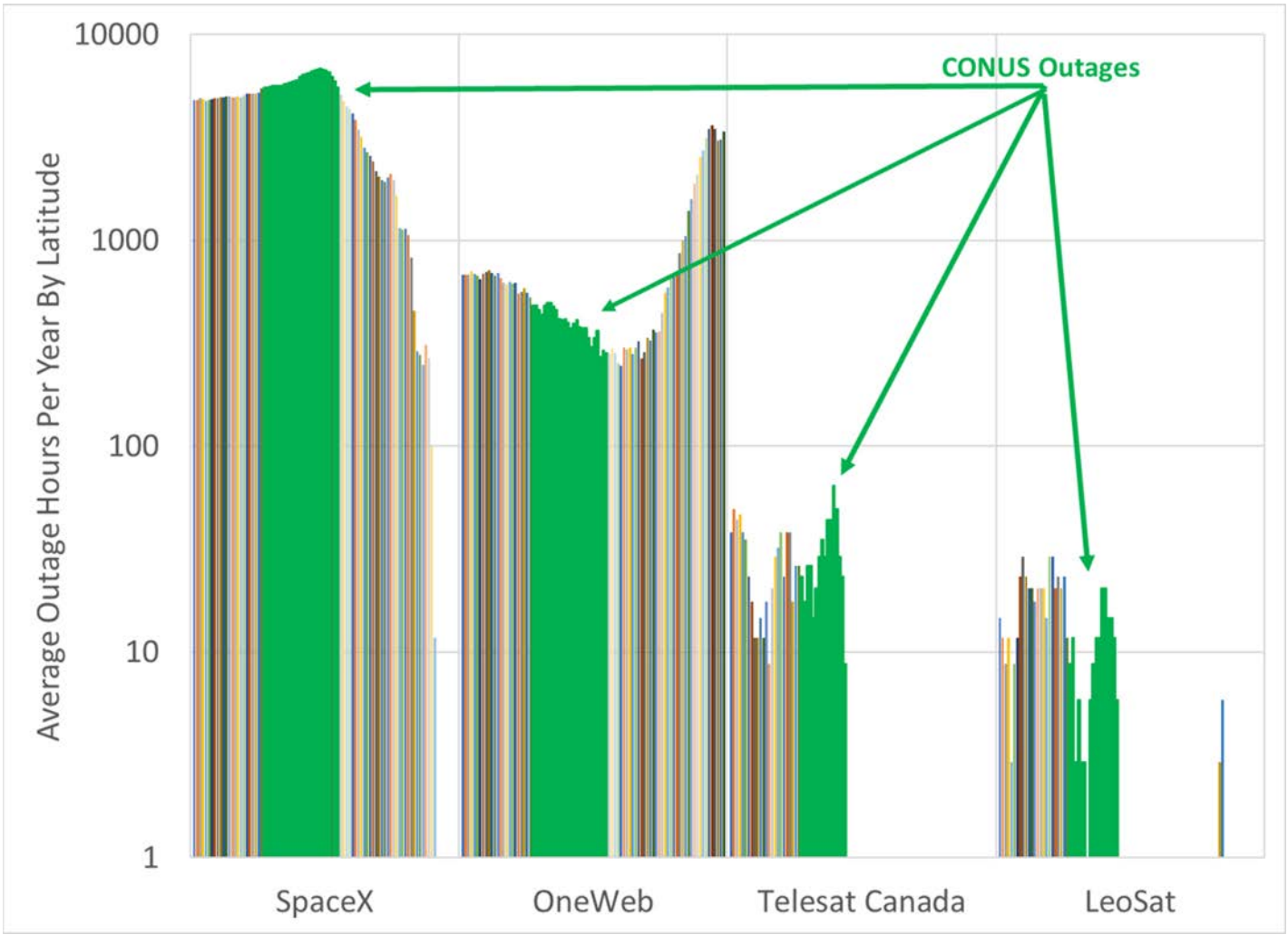
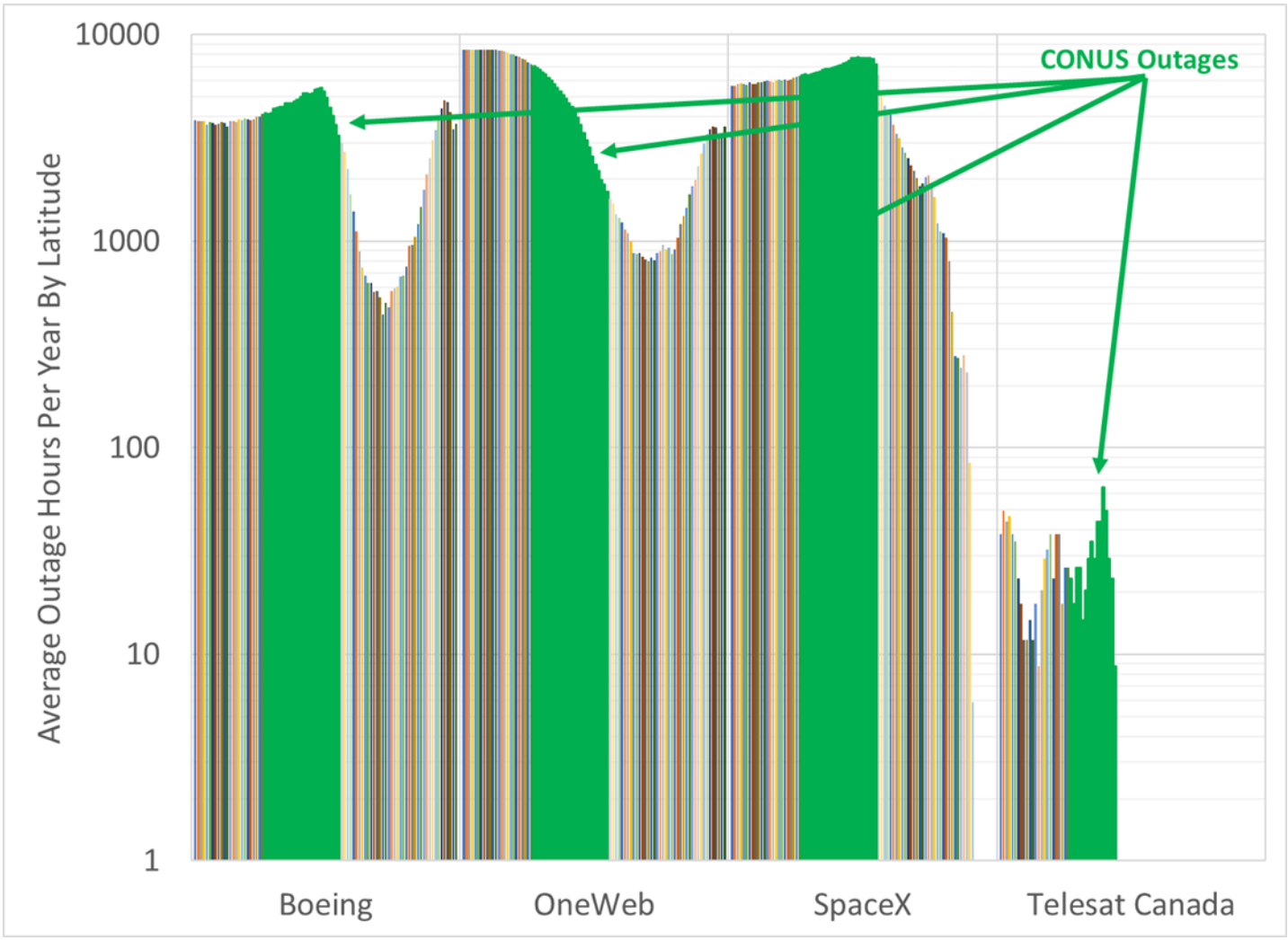


Exhibit 3B
V Band: Average Outage Hours Per Year for ViaSat-NGSO from Its Avoiding In-Line Events with Other NGSOs (From 0º to 90º Latitude)



DECLARATION

I hereby declare that I am the technically qualified person responsible for preparation of the engineering information contained in these Reply Comments of ViaSat, Inc. ("Reply Comments"), that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted with these Reply Comments, and that it is complete and accurate to the best of my knowledge, information and belief.

Daryl T. Hunter, P.E.
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April 10, 2017